Attachment 2

Outline Summary of the National Academies Study on
Alternatives for Control of Slightly Contaminated Solid Material

A. BACKGROUND

In June 1999, the NRC published in the Federal Register (64 FR 35090), for public comment, an Issues Paper indicating that the NRC was examining its approach for control of solid material. To provide further opportunity for public input, the NRC held a series of public meetings during fall 1999. In March 2000, the NRC staff provided the Commission with information (SECY-00-0070) on the diversity of views expressed in public comments received on the Issues Paper. In addition, SECY-00-0070 provided the status of the staff's technical analyses and also noted the related actions of international and national organizations and agencies. Based on these various factors, SECY-00-0070 recommended that a final decision on whether to proceed with rulemaking be deferred and that the National Academies (NA) be requested to conduct a study of alternatives for control of solid materials.

In an August 2000 Staff Requirements Memorandum (SRM), the Commission approved the staff's recommendations as contained in SECY-00-0070, including deferral of rulemaking and the conduct of a study by the NA.

B. AWARD OF A CONTRACT TO NA

Consistent with the direction in the August 2000 SRM, a contract was awarded, in August 2000, for the NA to conduct a study of, and provide recommendations on, possible alternatives for controlling the release of solid materials.

The statement of work in the contract called for the NA to:

1) Make a comprehensive review of a wide variety of factors which can impact possible alternatives for control of solid materials, including: (a) technical bases development, including ongoing and planned staff activities; (b) studies by the U.S. Environmental Protection Agency (EPA) on environmental impacts of clearance of materials and exemption of materials containing naturally occurring radioactive material (NORM) (e.g., coal ash), and development of screening guidelines for import of material; (c) criteria and guidelines of the U.S. Department of Energy (DOE) for controlling release of solid materials and current activities of DOE to review its policies on release of materials; (d) recommendations or policies of the Conference of Radiation Control Program Directors (CRCPD) on control of solid materials; (e) experience of individual States regarding release criteria for solid materials, in particular issues related to disposal of radioactive materials at landfills and issues related to NORM; (f) directives, standards, or recommendations of the International Atomic Energy Agency (IAEA) or European Union (EU) as they pertain to international trade and import; (g) recommendations of the International Commission on Radiological Protection (ICRP) and National Council on Radiation Protection and Measurements; (h) implications of the issuance of a standard in 1999 by the American National Standards Institute (ANSI) (N13.12) and the National

Technology Transfer and Advancement Act of 1995; and (i) stakeholder input and comments on prior NRC proposals on possible alternatives for control of solid material.

2) Explicitly consider how to address public perception of risks associated with alternative approaches and to provide recommendations on how concerns of stakeholders can be integrated into an acceptable approach for control of solid materials;

3) Determine whether there is sufficient technical bases to establish criteria for control of solid materials, including an evaluation of available dose analyses methods and measurement methods for demonstrating compliance with any criteria established, and to indicate what additional analyses or technical bases are needed before criteria can be established;

4) Provide recommendations on whether the NRC should: (a) continue the current system of case-by-case decisions, (b) establish a national standard by rulemaking, or (c) consider another alternative approach. As part of the recommendation, the contract stated that: (a) if continuation of the current approach was recommended, the NA should also provide recommendations on whether the current system should be revised, and, if so, how it should be revised; and (b) if promulgation of a national standard was recommended, the NA should also recommend an approach, set the basis for release criteria, and suggest a basis for establishing a numerical limit or, if it deems appropriate, propose a numerical limit.

5) The contract also noted that the NA should recommend how NRC might consider international clearance standards in its efforts.

More information on the project scope can be found in the NA report, Appendix C, and on their website: http://www4.nas.edu/webcr.nsf/ProjectScopeDisplay/BEES-J-00-02-A?OpenDocument.

C. ACTIVITIES CONDUCTED BY THE NA

Following award of the contract to the NA, the first step in the NA study was formation of a study committee. The study committee included representatives from academia, scientific and health organizations, and public groups and was formally approved by the NA in February 2001. More information on the membership of the NA study committee can be found in the NA report in Appendix A and on the NA website.

In conducting the study, the NA committee held an information gathering meeting in January 2001, with representatives of NRC, DOE, and EPA. Subsequently the NA held additional information gathering meetings in March and June 2001, with a variety of stakeholders. The invited stakeholder groups include representatives from NRC licensees and licensee associations, metals and cement industry organizations, solid waste organizations, a licensed waste disposal company, a waste broker, States and State associations, citizen groups, and international agencies. The June 2001 meeting also involved obtaining information on technical support documents.

Following the stakeholder meetings, the NA held five additional meetings in July, August, and December 2001, to develop and review draft report sections and chapters and to develop findings and recommendations.

More information about the meetings held by the study committee can be found on both the NA website as well as on the NRC website, as part of the Quarterly reports prepared by the NRC, at http://www.nrc.gov/materials/medical.html.

D. SUBMITTAL OF FINAL NA REPORT TO THE NRC

The final report from the NA containing their findings and recommendations was submitted to the NRC in March 2002.

E. SUMMARY OF NA REPORT AND CHAPTER FINDINGS

E.1 Overall summary

The NA report is a 10-chapter report discussing a range of topics related to control of solid materials, including the regulatory framework, anticipated inventories of materials, pathways and costs of disposition, methodology for dose analysis, measurement issues, international approaches, stakeholder reactions, and a framework for decision-making. The first chapter presents introductory material; each of the subsequent chapters discusses a specific technical or policy area and contains a set of findings related to that chapter. Based on these findings, Chapter 10 presents two overarching findings and seven recommendations.

The following sections briefly summarize Chapters 2 through 9 of the NA report.

E.2 Summary of Chapter 2: The Regulatory Framework

E.2.1 Risk-based standards: The report notes that the trend in environmental regulation is towards risk-based standards which typically focus on estimated increased lifetime risks posed by regulated material. The report notes:

a) Need for transparency: An important challenge is to ensure that the methods used, including the simplifying assumptions and inherent constraints, are sufficiently transparent to both technical peers and the concerned public.

b) Benefits of risk-based approach: Benefits include: (1) ensures that contaminant levels are controlled to achieve acceptable levels of public health protection; (2) promotes consistency among different regulations, (3) is responsive to public policy decisions; and (4) is assumed to be rationally based on estimates of dose and risk. Although such dose-based standards have unavoidable uncertainties built into them, these uncertainties are offset by the approach's capacity to incorporate policy determinations into a rigorous scientifically based framework.

c) Assessing risk: Part of a risk-based approach is assessing the dose which involves:

    1) Critical group: A set of exposure scenarios and resultant potential dose to a

certain group of individuals, referred to as the “critical group,” must be developed in order to assess risk.

2) Multiple exposures: An important aspect that must be considered in assessing the risk is the potential that a member of the public could be exposed to multiple exposure pathways. Thus, the standard for release of a site may be a relatively large fraction of the public exposure safety limit, while the standard for release of material into commerce would be a much smaller fraction.

3) Uncertainty: The inherent complexity of dose assessment analyses requires that numerous simplifying assumptions be made and that there be an assessment of the uncertainty in the analyses and a sensitivity analysis of the results.

E.2.2 Technology based standards:

a) Characteristics: the report indicates that technology-based standards may be based on the limitations of existing control or measurement technologies and notes that:

   1) NRC’s existing guidance documents for control of solid materials are based on survey practices in use in the 1970s and 1980s.

   2) Some environmental laws are based on “best available technology ” in which the focus is not on risk, which is difficult to estimate, but on promoting the use of the most advanced technologies and fostering their further development.

   3) A technology based regulation in this area could prescribe limits on radioactivity levels or require that specific instruments or methods be employed.

b) Advantages and disadvantages: Technology-based regulation has the advantage of being relatively simple to implement. A major disadvantage is that, if potential impacts are not carefully considered, it can result in either under-regulation and thus increased risk to the public or over-regulation and hence increased costs to regulated industries. Thus, an analysis of risk reduction and cost-benefit should be part of any development of technology-based regulations.

E.2.3 Critical uncertainties: The report notes that there are several important uncertainties including the following:

a) Buildup of radioactivity: The risk that radionuclides will concentrate in certain solid materials released into commerce.

b) Ability to measure: The capabilities of existing radiation monitoring equipment and survey methods.

c) Multiple exposures: The significance of multiple exposure pathways for cumulative exposure to the public.

d) Accuracy: The reliability of conservative hypotheses in designating critical groups.

E.2.4 Historical evolution of the regulatory framework for control of solid materials: The report discusses the historical evolution of a regulatory framework in this area.

a) The Atomic Energy Act (AEA) and the Code of Federal Regulations (CFR): Issuance of the AEA and Title 10 of the CFR established licensing requirements for all practices using nuclear materials.

b) Liquid and gas effluents: The NRC's general radiation protection regulations in 10 CFR Part 20 contain permissible levels of radioactivity for gaseous and liquid effluents.

c) Solid materials:

    1) Handling of materials with larger amounts of radioactivity: 10 CFR 61 contains disposal requirements for 3 classes of low-level radioactive waste (LLW), i.e., Class A, B, and C, which impose upper bounds for radioactive content.

    2) Handling of materials with lower amounts of radioactivity: There are no requirements in 10 CFR 61 specifying a threshold content of radioactivity below which material may be treated as non-radioactive waste.

    3) Current practice for handling materials with lower amounts, or no, radioactivity: Without a regulatory basis for what solid material can be treated as non-radioactive, NRC has used Regulatory Guide 1.86 which contains acceptable surface contamination levels for equipment based on detection limits of instruments available at the time of the guide's issuance in 1974. NRC also uses Inspection and Enforcement Circular 81-07 in its reviews of material and equipment and 10 CFR 20.2002 in case-by-case reviews for disposing of radioactive solid materials in unlicensed facilities when procedures are not specifically prescribed by existing regulations using license conditions and existing regulatory guidance.

E.2.5 Past efforts to set standards for solid materials: The report notes NRC's efforts to set standards in this area:

a) Issuance of the Below Regulatory Concern Policy: In 1990, NRC sought to establish a policy by which certain radiation levels would be considered "below regulatory concern" (BRC) to establish threshold levels of radioactivity below which solid materials could be cleared from further regulatory control. There was significant public comment on the BRC policy and NRC rescinded the policy following Congressional revocation of it in 1992.

b) 1999 Issues Paper and NUREG-1640: In June 1999, NRC released an Issues Paper containing issues and alternatives for discussion regarding alternatives for the control of solid materials. At that same time, NRC issued for public comment NUREG-1640 which contained a method for converting dose-based risks to concentration of radioactivity on materials by evaluating a range of pathway exposure scenarios.

E.2.6 Current regulations and guidelines in the U.S. pertinent to solid materials: The report highlights some pertinent regulations and states that the levels of protection afforded by federal regulation of radioactive materials vary widely.

a) NRC regulations on license termination requirements for structures and lands: NRC has license termination requirements in Subpart E of 10 CFR 20 which require that facilities meet a 0.25 mSv/yr (25 mrem/yr) dose standard before they can be released for unrestricted use.

b) NRC regulations on control of solid materials: There are currently no generally applicable NRC regulations for solid materials with low amounts of radioactivity, except for disposal of H-3 or C-14 in animal tissue in 10 CFR 20.2005(a)(2). Except for that one area, NRC evaluates control of solid materials on a case-by-case basis as noted in Section E.2.4(c)(3). The report reviewed SECY-00-0070 which lists advantages and disadvantages of the current "non-regulation" based NRC approach and generally agrees with that appraisal.

c) State guidelines: The report notes that for some NRC requirements, such as basic radiation standards or those that have significant implications for interstate commerce, Agreement States must adopt essentially identical requirements to NRC. States may also adopt more restrictive requirements if they have an adequate supporting bases. Criteria that have been applied by States on a case-by-case basis for solid material have included use of radiation levels indistinguishable from background, guidelines similar or equivalent to Regulatory Guide 1.86, and the use of dose-based analysis.

d) DOE guidelines: The DOE's standards for surface contamination are set forth in DOE Order 5400.5 which incorporates Regulatory Guide 1.86. The DOE was considering a large scale recycling project in 1996 at its Oak Ridge complex, but in response to strong opposition from the private and public sectors, DOE issued a moratorium in January 2000 on releases of volume contaminated materials and also suspended unrestricted recycling of scrap metal in July 2000. DOE currently has initiated a process for preparing a programmatic environmental impact statement (PEIS) on alternatives for recycling surface contaminated metals.

e) EPA regulations: The report notes that:

   1) EPA emissions and operations standards: EPA regulations in 40 CFR 190 set limits of 0.25 mSv/yr (25 mrem/yr) on nuclear plant operation, in 40 CFR 141-142 set a 40 µSv/yr (4 mrem/yr) standard from drinking water, and in 40 CFR 61 set limits of 0.1 mSv/yr (10 mrem/yr) from airborne emissions.

   2) EPA risk goals for standards: EPA has developed standards for Superfund sites based on having remediation goals being consistent with a lifetime risk range of 10^{-4} to 10^{-6}.

3) EPA clearance efforts: EPA does not have a clearance related effort ongoing but has focused its efforts on promoting consistent international import-export controls for materials containing residual radioactivity.

f) As low as reasonably achievable (ALARA) requirements: With regard to application of ALARA in requirements, the report noted that it is not appropriate to apply the ALARA principle at or below the dose limits that are typically proposed for clearance. The rationale given is that these are not dose safety limits but are levels at which solid material may be released, and that dose levels of 1 µSv/yr to 0.1 mSv/yr (0.1 to 10 mrem/yr) are already orders of magnitude below natural background and below the variation in natural background dose.

g) Technologically enhanced naturally occurring radioactive material (TENORM): Federal regulation of TENORM has been largely absent (an exception to this is DOE Order 5400.5 which covers this material for activities authorized under the AEA). This regulatory gap in regulation of TENORM persists despite the fact that many forms of TENORM can be substantially more radioactive than low level waste subject to regulation under the AEA. The existing State regulations that apply to TENORM have been largely limited to disposal and handling requirements and, while the CRCPD has drafted model state regulations for TENORM, they have not be finalized nor adopted by any State. State regulations remain limited and vary from State to State.

E.2.7 Stakeholder concerns with regulations in this area: The report discusses stakeholder reactions to a previous effort in this area, the 1990 BRC policy, and relates the comments to current efforts on control of solid materials.

a) BRC policy: The report states that NRC public meetings on the BRC policy were contentious and notes that:

1) Themes of public comments: The prevailing sentiment was one of opposition to the BRC policy. Themes of opposition included: (a) extreme concern over possible deregulation of nuclear power waste, (b) opposition to recycling of materials into unlabeled consumer products; and (c) concern that the policy would permit a large number of deaths per year.

2) Overall concern with NRC: Stakeholder concerns centered on whether NRC could adequately protect the public.

3) Concern with radiation and trust of government: Many stakeholders expressed belief that low levels of radiation were much more harmful than the regulatory agencies had determined them to be.

4) Concerns with ability to monitor materials: There was concern that it would not be possible to monitor solid materials adequately before release.

5) Concerns over multiple exposures: Many stakeholders were concerned that the regulatory system failed to take into account multiple exposures.

6) Concerns over individual rights: Stakeholders were concerned that general standards for release would undermine individual rights to decide the nature and magnitude of risk to which members of the public would be exposed.

7) Support for BRC: The nuclear industry and some other stakeholders supported the policy on the grounds of economic and resource efficiency.

8) Termination of BRC policy: There was an effort at a consensus seeking process, however it did not succeed and the policy was nullified by Congress in 1992.

b) Current effort on control of solid materials: The report notes that many of the same concerns still exist today and stakeholders remain adamantly opposed to NRC rulemaking on control of solid materials.

E.2.6 Findings: Based on its review, the NA made the following specific findings with regard to the regulatory framework:

a) Finding 2.1 - Current practice and lack of overall approach: The NRC does not have a clear, overarching policy statement for management and disposition of solid material. However, solid material has been released from licensed facilities into general commerce or landfill disposal for many years pursuant to existing guidelines (e.g., Regulatory Guide 1.86) and/or following case-by-case reviews. The NRC advised the committee of no database for these releases.

b) Finding 2.2 - Dose-based standard: A dose-based clearance standard can be linked to the estimated risk to an individual in a critical group from the release of solid material. The general regulatory trend is toward standards that are explicitly grounded in estimating risks.

c) Finding 2.3 - Current practice has been used satisfactorily: For clearance of surface-contaminated solid materials, the clearance practices regulated by the NRC and Agreement States are based on the guidance document Regulatory Guide 1.86, which is technology based and has been used satisfactorily in the absence of a complete standard since 1974.

d) Finding 2.4 - Volume contaminated material: For clearance of volume-contaminated solid materials, the NRC has no specific standards in guidance or regulations. Volume-contaminated material is evaluated on a case-by-case basis. This case-by-case approach is flexible, but it is limited by outdated, incomplete guidance, which may lead to determinations that are inconsistent.

e) Finding 2.5 - Regulation of TENORM is inconsistent or absent: Industrial activities are generating very large quantities of TENORM. Federal regulation of TENORM has been largely absent. State regulations vary in breadth and depth.

E.3 Summary of Chapter 3: Anticipated Inventories of Solid Materials

E.3.1 General: This chapter presents information on quantities of solid material expected to arise over the next 25 years and makes the following general points in considering inventories of materials:

a) Scarcity of information and impact on analyses: The report did not find readily available information on inventory and anticipated dates for disposal of materials, and therefore the report notes that one must often infer or estimate the amount of materials that may satisfy particular clearance criteria based on information created for a different purpose.

b) Source used: The report relied heavily on a recent draft letter report on material inventory developed for the NRC by its contractor, SC&A.

E.3.2 Need for NRC awareness of implications of its actions: The report notes that NRC needs to be aware that any new regulations that it issues could have impacts on management of contaminated materials currently unregulated at the federal level.

E.3.3 Inventories of solid materials: The report provides information as follows:

a) Power reactors:

    1) Inventory from reactors: The report notes that some data are available for estimating types and annual quantities of materials from power reactors and refers to several NUREG/CRs containing decommissioning data. From this information, tables are provided on materials inventories.

    2) Relation of reactors to other facilities: Most material from NRC-licensed facilities comes from nuclear reactors.

    3) Types of materials: Material to be dispositioned at decommissioning of reactors includes activated materials; nonreusable materials, such as ion exchange resins, filters, and insulation; and metallic solid material that might be uncontaminated but is from a radioactive work area or might be only slightly contaminated.

    4) Concrete: Structural concrete can also be available at decommissioning. The volume of concrete is larger than the combined volumes of all other material by at least a factor of 10. Determining what to do with the concrete is complicated by several factors, including determining quantities and levels of radionuclides that have penetrated into the concrete and sampling costs to demonstrate the material is clean. Public perception and regulatory factors can also affect disposition choices such as whether the concrete is left as on-site fill after a license is terminated.

    5) Timing: Most of the inventory will arise during decommissioning of reactors during an extended time period between the years 2006 and 2030. If licenses are extended for an additional 20 years, which seems probable for most facilities, little material would be generated until the time period 2030 to 2050.

6) Comparison of reactor inventory with total scrap: The amount of ferrous metal scrap arising from decommissioning of nuclear reactors would constitute only about 0.1 percent of the total scrap steel recycled each year by the U.S. steel industry; therefore the effect on the available scrap metal resources is negligible if the metal from nuclear reactors is not recycled.

b) Non-power reactors: In estimating inventory, the report notes that the weights of structural steel and concrete are assumed to all be clearable without any exclusions for LLW materials. The inventory of steel and concrete represents about 1.4 percent of the weight from power reactors.

c) NRC licensed fuel cycle and non-fuel-cycle facilities: The total quantity of materials compared to reactors is considered to be small.

d) Non-NRC facilities: The report also discussed inventories existing at DOE facilities and at EPA superfund sites, as well as inventories of NORM and TENORM.

E.3.3 Findings: Based on its review, the NA made the following specific findings with regard to inventories of material:

a) Finding 3.1 - Quantities of material from licensed facilities and comparison to general scrap: Licensees may seek to clear about 740,000 metric tons of metal that arise from decommissioning the current population of U.S. power reactors during the period 2006 to 2030 (about 30,000 to 42,000 metric tons per year). About 8,500 metric tons per year are expected to arise from decommissioning NRC-licensed facilities other than power reactors during the same time period. The total quantity of metal from both power reactor and non-power reactor licensees, up to approximately 50,000 metric tons per year, represents about 0.1 percent of the total obsolete steel scrap that might be recycled during that same 25-year period.

b) Finding 3.2 - Timing of materials available for release: If most of the licensees of currently operating reactors obtain 20-year license extensions, relatively little solid material will arise from power plant decommissioning during the 2006 to 2030 period.

c) Finding 3.3 - Concrete: Because of the difficulty of determining the quantities and levels of contamination that have penetrated into the concrete, concrete is generally considered to be volume contaminated. Concrete constitutes more than 90 percent of the total solid material arising from decommissioning population of U.S. power reactors.

d) Finding 3.4 - DOE facilities and comparison to NRC facilities: About 1 million metric tons of metal, and about 3.7 million to greater than 12 million metric tons of concrete, are projected to arise from cleanup and decommissioning of DOE facilities during the coming 25 years. This quantity of metal is comparable to the quantity of metal estimated to arise from decommissioning the population of U.S. power reactors and corresponds to only an additional 0.1 percent of the total obsolete steel scrap recycled in the United States during the same 25-year period.

e) Finding 3.5 - TENORM is largest quantity of material: TENORM is generated in the United States at an annual rate of about 2.3 million metric tons per year. The quantity of TENORM predicted to arise over the coming 25-year period is nearly 16 times larger than the quantity of solid material estimated to arise from decommissioning the population U.S. power reactors.

E.4 Summary of Chapter 4: Pathways and Estimated Costs

This chapter provides information on costs for different disposition alternatives.

E.4.1 Bases for disposition decisions and for developing costs:

a) Alternatives for disposition: In the cost analyses, the report assumes three possibilities for disposition of solid material arising from operation and decommissioning nuclear facilities (no release, clearance, and restricted use of material to certain authorized uses (the NA report refers to this alternative as "conditional clearance")).

b) Illustration of disposition paths and decision points: The NA report presents Figure 4-1 which illustrates the general decision pathway for disposition.

c) Disposition system decisions: The report presents a discussion of some of the factors that go into decisions regarding disposition of material, including: (1) material that might go to waste disposal under a no release option; (2) sorting of material; (3) types of restricted use options; (4) the length of a storage period for decay of material (including the material half-life, facility storage capability, financial stability of the facility owner, costs, and public views); and (5) potential decontamination of materials.

E.4.2 Relative costs: The report develops some estimated costs based on the following:

b) Costs not included in analysis: The report notes that costs of decontamination, segmentation of materials, and transport costs are not included in the report's analysis.

c) Factors in determining costs: Determining the costs for disposition can be difficult but some useful data are available. Many factors affect costs, including volume, physical and chemical characteristics of the material, taxes and fees, and past relationship between the generator and disposal facility.

d) Nature of analysis: The report notes that it does not contain a detailed analysis of all factors, nor did it find that the NRC had prepared a detailed economic analysis. The analysis in the report principally focuses on costs of disposal at a licensed waste disposal facility, cost of placement in a landfill, and cost saved by clearance.

    1) LLW site disposal cost: The report notes that the disposal cost of waste from decommissioning can constitute a major share of the total cost of decommissioning. Costs for disposal in commercial LLW sites at Barnwell, US Ecology, and Envirocare are presented in the report.

2) Landfill disposal costs Costs for disposal in Subtitle C and D landfill sites are presented in the report.

e) Comparative costs of no release and restricted use: Based on estimated volumes of metals sent to LLW, assuming that there was a “no release” approach and all material went to a LLW site, compared to the same volumes sent under a restricted use approach to Subtitle C or D landfills, and using pertinent cost information, the report notes that landfill disposal is significantly less expensive.

f) Concrete costs: The costs of disposal of concrete at Envirocare, at a landfill site, and if reused in roadway foundations, were compared.

E.4.3 Finding: Based on the analysis in Chapter 4, the NA report made the following finding:

a) Finding 4.1 - Cost of disposal of material in LLW sites compared to landfills: Disposal of all solid material arising from decommissioning U.S. power reactors into LLW sites would be about $4.5 to $11.7 billion as compared to disposal at Subtitle C or D landfills which would be much cheaper ($0.3 billion to $1 billion). If the material is cleared the costs would be lower and might even result in some income arising from the sale of scrap materials for recycle or reuse.

E.5 Summary of Chapter 5: Methodology for Dose Analysis

E.5.1 Key technical assessments of annual doses associated with clearance of solid material: The report notes that there has been a considerable effort in several countries in studying dose factors for clearance of solid material. Critical groups are used in these studies to identify the most exposed group of persons and bound the potential dose that any other member of the general public may receive from solid material that is cleared.

a) NRC studies: Two NRC studies were evaluated. NUREG-1640 is considered state of the art in its risk assessment methodology and provides an in-depth analysis of recycling of steel, copper, aluminum and concrete with either volumetric or surficial contamination. The conceptual plan of NUREG-1640 was found to be the best of all studies reviewed. A formal uncertainty analysis is incorporated into NUREG-1640, unlike the other studies. A decision needs to be made about which dose factor to use for deriving secondary activity (radionuclide concentration) standards. From a scientific perspective, the NAS committee does not believe it is cost-effective to repeat the work done in NUREG-1640, in response to a previous conflict of interest question. An independent technical review of NUREG-1640 was performed by the Center for Nuclear Waste Regulatory Analysis, but there has not been a thorough review of the parameters and associated ranges in the report. Other limitations of NUREG-1640 are noted in E.5.4 below.

   The second NRC study evaluated was a risk assessment of scrap metals from gaseous diffusion plants and other sources, which was published in 1980 in report NUREG-0518. NUREG-0518 does not contain uncertainty estimates and relies instead on conservative bounding conditions. There was negative public reaction to this effort at that time and further efforts were suspended.

b) Environmental Protection Agency documents on dose factors: The 1997 Technical Support Document (TSD 97) provides estimates on sources and inventories of metal scrap from government and commercial sources and contains information on dose factors, detection limits, scrap metal processing methods, scenarios, and timetables for when certain solid materials may become available. NCRP critiqued TSD 97 and concluded that: (a) TSD 97 overemphasized the evaluation of a limited number of scenarios; (b) uncertainties should be analyzed using a probabilistic risk assessment model; and (c) implementation methods should be considered for standards development.

c) American National Standards Institute and Health Physics Society Standard N13.12-1999: The NA report notes that the primary dose standard in this standard is 10 uSv/yr (1 mrem/yr), which is consistent with international values, and contains useful information, including an implementation protocol. However, this standard did not use a range of dose estimates across categories to define a critical group in a documented manner, so the NA report stated the method for deriving the screening levels is not traceable and therefore not judged or ranked by the NA committee.

d) International Atomic Energy Agency documents: The NA report reviewed two documents developed by the International Atomic Energy Agency (IAEA) - Safety Practice No. 111-P.1-1 and TECDOC-855. The NA report notes that the first report provides the IAEA's dose factors that were derived based on technical assessment principles established in IAEA Safety Series No. 89 (SS89), and that the NRC has not developed a generic document such as SS89. Two potential differences were identified between IAEA recommendations and existing U.S. concepts for control of solid material, which concern the potential effect of similar practices on critical groups or populations exposed and the issue of dilution of material or fractionation of practice. The NA report also noted that both documents do not include uncertainty analyses and, in Safety Practice No. 111-P.1-1, certain parameter values were assigned without a citation reference. TECDOC-855 was developed in a similar fashion as ANSI/HPS N13.12-1999, but was considered traceable by the NA committee because TECDOC-855 included the steps taken to discount various studies that were not used to form the technical basis for the dose factors.

e) European Commission documents: Two reports were reviewed that were prepared by the European Commission (EC). These reports address metals recycling, equipment and building reuse and building demolition. The NA noted uncertainty estimates were not performed and that a few scenarios were assumed to be representative of many other scenarios. A suggestion made by the NAS report was for NRC to consider certain assumptions used to derive the dose factors in these EC reports, such as the variation in contaminant level of a material being surveyed for clearance.

E.5.2 Comparison of clearance studies: The studies reviewed do not always agree on the numerical value for the best estimate of the dose factor. Although there is relatively good agreement between the NRC and EPA studies, there is less agreement between the NRC study and those conducted by the IAEA and EC. Dissimilarities are attributed to differences in assumptions, critical groups, exposure scenarios, degree of conservatism, and the presumed heterogeneity of contamination in or on the solid material. The NA committee evaluated the uncertainty in the dose factors by estimating the variability between studies and concluded that there is greater variability than predicted by the uncertainty bands utilized in NUREG-1640. Thus, the uncertainty bands in NUREG-1640 may need to be rechecked and, at a minimum, the NRC should be able to understand and explain the discrepancy. An order of magnitude difference in dose estimates is reasonable for risk estimates of this type, but an international bench marking exercise would make sense for major disagreements.

a) Usefulness and quality of dose factors: Some dose factors can be shown to be reliable, such as those involving external gamma radiation, but some other dose factors require the use of parameters that are highly uncertain. A way to account for uncertainty is to set the dose factor at a fixed margin above the best estimate in order to compensate for incomplete knowledge. The selection of an additional margin of protection is a policy decision - if one is not chosen, then uncertainties should be evaluated closely or, less preferably, rely on the protectiveness of the analysts. Decision-makers need to be informed of the quality of the supporting information. One way to deal with hypothetical model error is to adopt a policy of "adaptive management" in which real-world performance is validated after implementation or through retrospective analysis of case studies, which is endorsed by the IAEA. Such a validation program could be used to adjust dose factors after a standard is implemented, if needed, but for solid materials cleared from NRC facilities under a potential future standard, field data will probably only be useful in assessing how well the clearance models have bounded the concentrations and estimated the doses. A modest monitoring effort would boost confidence in the dose factors.

b) General limitations of the reviewed studies:

    1) Failure to consider uncertainties associate with implementation of a primary dose standard: Dose factors are useful tools, but have practical value only within a specific implementation protocol that can itself introduce additional uncertainties, such as averaging error, sampling error, rounding error and treatment of multiple radionuclides.

    2) Lack of validation of model estimates: A validation program should be used to correct and refine a clearance standard, given the uncertainties in the dose factors. Only one study has attempted this and the NA committee encourages future efforts.

    3) Lack of inclusion of accidents and human errors in the dose factors: The IAEA recommends consideration of accidents in estimating exposures of the public from disposal exemptions and human error can initiate or contribute to accidents in clearance. Human error was not explicitly addressed in any of the studies reviewed by the NA, but NRC is assessing one form of human error (accidents). It must be presumed that some shipment will leave licensed facilities with contamination in excess of a clearance standard and a probabilistic-based study, such as NUREG-1640, can account for this possibility. Human error may only have a limited impact on dose factors.

c) Potential inconsistencies in dose factors between countries: Two types of inconsistencies exist, which are the primary dose standard and the dose factors that are used to derive the secondary clearance standard. Consistency of clearance standards across national borders is desirable, but it would be inappropriate for one country to change scientific evidence to achieve consistency with standards in effect in other countries because it could undermine public confidence. If rationalization of transnational consistency of clearance dose standards becomes paramount, the changes should be based on a policy choice.

E.5.3 Detailed comments on NUREG-1640 The NA committee believes that the following issues with NUREG-1640 have to be considered explicitly in the technical support process:

a) Landfill disposal scenarios: Landfill issues were difficult to understand and require clarification and justification. Examples are the fraction of material that goes to a landfill, alternative economic models for landfill deposits, and uncertainties related to leaching rates, liner failure, long-range transport issues and lack of a defined critical group.

b) Incineration pathway: This pathway was not addressed and should be explicitly considered even though it is unlikely to be significant.

c) Sensitivity analysis: A sensitivity analysis would be constructive because it would yield information about the significance of a parameter's value and would allow a better assessment of the effect of the parameter's uncertainty on the calculated dose factors.

d) Validation: There is no bench marking or validation and it would be appropriate to demonstrate the validity of the modeling technique.

e) Sample calculations: More sample calculations could have provided clarity as to the overall method.

f) Multiple pathways: Multiple pathways should be considered, as recommended by IAEA.

g) Resuspension of contamination: There is only limited consideration of resuspension of surface contamination into the air. At a minimum, a sensitivity analysis should be performed to inform readers as to how the dose factors would vary with a change in the resuspension coefficient. A sufficient technical basis may not exist for assigning a credible uncertainty factor to certain types of releases that are sensitive to resuspension. If so, such clearance categories could be excluded by regulation until a sufficient technical basis is developed.

h) Collective dose: The technical analysis does not include collective dose and focuses on individual dose. Other studies have examined collective dose. It may be of interest in shaping policy to have some idea of collective dose.

i) Size of critical groups: The total number of people exposed in any critical group is not discussed. Knowledge of the approximate size of critical groups assists in building confidence that a more important subgroup has not been overlooked.

j) Total activity and mass balance: There is limited information on total activity buildup and mass balance. Although this lack of information made the NA committee uncomfortable it believes that buildup is not likely to be significant and supporting estimates are useful.

k) Accounting for human error: Human error is not accounted for. More analysis is needed because it is a good risk assessment practice and, specifically for the control of solid materials, the potential consequences may be sufficient to require further evaluation.

l) Uncertainty in conversion between intake and dose: The uncertainty in the coefficients that convert inhalation and ingestion to dose were not considered, but should be explicitly considered even though their overall contribution may not be significant to other uncertainties that enter the estimate of dose factors.

E.5.4 Findings

a) Finding 5.1 - Development of dose factors: Analytical work in the United States and abroad over the past two decades is useful in understanding the likely doses associated with exposure scenarios that might occur under various clearance standards. Much of the technical analysis in this field has the objective of understanding "dose factors," which to date have been analyzed in depth only for clearance scenarios. A dose factor is used to convert a concentration of radioactivity that is about to be released, whether it be confined to a surface or contained within a volume, to a primary dose level (measured in microsieverts per year or millirem per year). With such a dose factor in hand, a primary dose standard can be converted to obtain a secondary clearance standard in terms of radionuclide activity, which could then be used at NRC-licensed facilities. A dose factor can be used with any choice of primary dose standard.

b) Finding 5.2 - Standard of 10 µSv/yr (1 mrem/yr): Selecting a primary dose standard is a policy choice, albeit one informed by scientific estimates of the health risk associated with various doses. For instance, as shown in Table 1-2 of the report, a lifetime dose rate of 10 µSv/yr (1 mrem/yr) equates to an estimated increased lifetime cancer risk of $5x10^{-5}$, which falls within the range of acceptable lifetime risks of $5x10^{-4}$ to 10^{-6} used in developing health-based radiation standards other than radon in the United States. When setting primary dose standards, regulators can make a policy decision to include a level of conservatism such that the final standard is in excess of the "best-estimate" dose factor and in this way account for uncertainty (e.g., selecting the 90th, 95th, or other percentile in the distribution for the dose factor, instead of the best-estimate value).

c) Finding 5.3 - Uncertainty and variations of dose factors among analysts: The uncertainty in dose factor estimates is a key technical issue. When an uncertainty has been estimated, a quantitative determination can be made of the likelihood that the dose to an individual in the critical group will be below the primary dose standard. Quantitative uncertainty estimates can also assist regulators in assigning a level of conservatism to dose factors in excess of the best estimate. Dose factors developed by analysts from different countries show wide variation, which highlights the need for careful consideration of uncertainties.

d) Finding 5.4 - Merits of NUREG-1640: The committee concludes from its review that of the various reports, draft NUREG-1640 provides a conceptual framework that best represents the current state of the art in risk assessment, particularly with regard to its incorporation of formal uncertainty, as judged using recommendations of this committee and other committees of the National Research Council. Once the limitations in draft NUREG-1640 have been resolved (see Findings 5.5 and 5.6) and the results are used in conjunction with appropriate dose-risk estimates, the NRC will have a sound basis for considering the risks associated with any proposed clearance standards and for assessing the uncertainty attached to these dose estimates.

e) Finding 5.5 - Need for re-assessment of NUREG-1640 parameters: The development of the NUREG-1640 draft has been clouded by questions of contractor conflict of interest. The mathematics and completeness of scenarios considered in draft NUREG-1640 have been verified through an audit carried out by another NRC contractor. The committee also carried out its own review that generally confirmed the reasonableness of several dose factor analyses. However, a thorough review of the choice of parameters and parameter ranges, term by term, is needed to complete the reassessment of draft NUREG-1640.

f) Finding 5.6 - Need to analyze human error, restricted use, and multiple exposure: Draft NUREG-1640 did not consider human error and its possible effect on dose factor predictions, nor did it consider scenarios involving multiple exposure pathways. In addition, draft NUREG-1640 does not provide a sufficient basis to analyze restricted use options, such as disposal in a Subtitle D landfill.

g) Finding 5.7 - Need to expand NUREG-1640 for other material, DOE material and TENORM: The dose factors developed in draft NUREG-1640 should not be used to derive clearance standards for categories of solid material other than those considered in the draft NUREG-1640, without first assessing the appropriateness of the underlying scenarios. Some of the dose factors developed in draft NUREG-1640 are likely to require modification when applied to other mixtures of radionuclides (e.g., mixtures in which transuranics dominate) and other clearance scenarios, such as may be relevant to DOE material and TENORM.

E.6 Summary of Chapter 6: Measurement Issues

This chapter provides information on measurement issues for different disposition alternatives.

E.6.1 Factors affecting ability to measure: The chapter provides information on:

a) Level of complexity: The quantitative determination of the identify and activity of radionuclides present in a sample is a process that ranges from straightforward to complex.

b) Factors affecting measurability:

    1) Concentration of nuclides on material: The concentration of any nuclides in samples to be measured is low relative to licensed levels, and the dose received by individuals from contact with these materials is a small fraction of natural background doses and thus too low to be directly measurable.

    2) Other factors: Because dose cannot be measured directly, the concentration of the radionuclide on the material is what is determined and this can be affected by many factors, including: (a) the magnitude of dose factors; (b) specific instrumentation used, including detection limits for both field survey instruments

and laboratory instruments; (c) counting conditions, including background radiation levels; (d) sample characteristics; and (e) identity and quantity of the radionuclide. NUREG-1507 discusses each of these factors in detail including their impact on the minimum detectable concentration (MDC).

E.6.2 Levels of detectability and measurement costs:

The report notes that a reasonable question to ask is whether a radionulide can be measured at the concentrations corresponding to a dose standard.

a) Evaluation factors:

   1) Use of EPA technical support document in analysis: To assess whether existing instrumentation can observe different radionuclide concentrations at low levels, the report used an EPA technical support document prepared in 1997 presenting MDC data from 24 laboratories.

   2) ANSI N13.2: The report also considered the conclusions of ANSI N13.2, which provides similar conclusions as the EPA technical support document for surface contamination.

   3) Costs of measurement: The cost of measurement activities depends on the difficulty of analysis. For clearance alternatives, the tradeoff between the cost of clearance and the cost of disposal at a LLW site will ultimately determine which option a licensee chooses. To provide some information in this area, the report provides some cost information on surveys.

b) Conclusions:

   1) The fraction of nuclides detectable under field conditions is 39 of 40 for 0.15 mSv/yr (15 mrem /yr), 31 of 40 for 10 µSv/yr (1 mrem/yr), and 11 of 40 for 1 µSv/yr (0.1 mrem/yr).

   2) For both volume contaminated and surface contaminated solid materials, measurement of radionuclide activity at levels being considered for dose based standards is not the limiting factor if the primary dose standard is at or above 10 µSv/yr (1 mrem/yr), in both laboratory and field measurements.

   3) Based on the short analysis done, the cost of sampling and analysis does not appear to be a constraint limiting an option for a dose standard at or above 1 µSv/yr (0.1 mrem/yr).

E.6.3 Current measurement practices of a waste broker

a) The report notes that waste brokers and processors handle a significant fraction of the 30,000 tons of waste materials processed in the U.S.

b) Waste brokers provide services for the disposition of solid materials and may transport, collect, or consolidate shipments or process waste.

c) If material is clean, a waste broker ships it to Subtitle D landfill. As a further check, portal monitors at the exit of the waste broker facility are used to ensure that the clean material shipped to a landfill does not trigger portal monitors upon arriving there.

E.6.4 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM): The report briefly discusses the MARSSIM methodology and notes:

a) MARSSIM includes a statistical sampling methodology suitable for release of land and buildings potentially containing residual radioactive material in soil or on building surfaces.

b) The MARSSIM method could be valuable tool for licensees in demonstrating compliance with the type of dose-based standards under consideration for control of solid material.

c) There are a number of radiation detection instruments available to scan surfaces and the characteristics of the detector enable the licensee to relate the release level to a corresponding instrument response, referred to as the “derived concentration guideline level.”

d) Having selected appropriate instrumentation, the licensee must then develop an integrated survey design, including collection of survey data and data assessment.

E.6.5 Findings: Based on the analysis in the chapter, the report made the following findings in Chapter 6:

a) Finding 6.1 - Complexity of measurements: The concentration of radioactive material in released solids directly affects radiation detection requirements and costs. Measurement of the amount of radioactive material in a solid matrix is a complex task. No single measurement method would be appropriate or adequate for all nuclides.

b) Finding 6.2 - Impact of measurement costs: The overall measurement costs affect clearance decisions. If the measurement costs are too high, it may be more cost-effective to dispose of the material as LLW.

c) Finding 6.3 - Ability and cost to measure at low levels: For a 10 µSv/yr (1 mrem/yr) or higher standard, the majority of radionuclides can be detected at reasonable costs in a laboratory setting. For a 1 µSv/yr (0.1 mrem/yr) standard, the measurement capability falls below the upper bound of MDCs for some radionuclides in some laboratories, although 85 percent of the radionuclides are still detectable. Using field measurements, a more rapid fall-off of detectability is observed at the lower dose levels, with 31 of 40 key radionuclides detectable at 10 µSv/yr (1 mrem/yr) and 11 of 40 detectable at 1 µSv/yr (0.1 mrem/yr).

E.7 Summary of Chapter 7: International Approaches to Clearance

This chapter provides information on international issues related to disposition alternatives.

E.7.1 The Global context:

a) Growth in import-export activities: Import-export involving recycled materials has increased greatly with the growth of international trade over the past several decades, particularly for metals such as steel, aluminum, copper, and nickel.

b) Level of trade: Scrap metal is actively traded worldwide and the U.S. imports about 3 million metric tons of scrap steel per year.

c) Orphan sources as a concern: An issue that has caused a concern both with the U.S. and the EU has been the introduction, whether accidental or deliberate, of sealed high radioactivity sources in metal scrap for recycling. These "orphan sources" can cause problems during the recycling of steel but are noted as being outside the scope of the NA report and are being addressed in a separate effort by NRC, EPA, and the EU.

E.7.2 Efforts by international organizations:

a) Development of Standards: Various international organizations, including the United Nations Scientific Committee on Exposure to Ionizing Radiation, the European Commission (EC), IAEA, ICRP, and EU have, in various stages of completion, work on standards for slightly radioactive solid material.

b) United Nations (UN) proposed guidelines: To address concerns about import-export of metal scrap with undetected levels of radioactivity above clearance levels, the UN Economic Commission for Europe proposed guidelines including: (1) prior notification to receivers of material of the origin of the material; (2) information on materials with NORM should also be provided; and (3) the information should be conveyed with the released material to the successive suppliers and buyers of the metal scrap.

c) EU directive: The EU has been establishing standards and methods of control for solid material within Europe. Clearance practices in the EU are subject to a directive of the Council of the EU of May 1996 which states that materials can be released from regulatory control if the quantities and concentrations of activity do not exceed the concentration limits in Table A of Annex I (from Council Directive 96/29/EURATOM), or that regulatory agencies can use their own assessment process to decide on concentration values if the associated dose level is on the order of 10 µSv/yr (1 mrem/yr) (collective dose of 1 man-Sv/yr (100 personrem/yr)).

d) Standards in EU nations: The report notes that EU countries are in various stages of developing detailed regulations to implement the 1996 EU directive. The report notes potential quantities of potentially clearable materials and notes (based on Table 7-1) that different clearance procedures are currently in use among EU countries.

e) Standards in other countries: It is noted that there is also potential for material release from other countries including Japan, Russia, India, and China.

E.7.3 Findings: Based on the analysis in the chapter, the report made the following findings in Chapter 7:

a) Finding 7.1 - EU and IAEA standards set at 10 µSv/yr (1 mrem/yr): The EU and the IAEA have each established a dose-based standard of 10 µSv/yr (1 mrem/yr) for clearance of solid materials. A collective dose standard is also included, expressed as a committed dose equivalent of 100 person-rem total effective dose equivalent per year.

b) Finding 7.2 - EU concentration tables: The EU has derived tables of radionuclide concentrations based on a set of exposure scenarios against which solid materials can be evaluated for clearance.

c) Finding 7.3 - EU and IAEA data and policies: A body of science, policy, and literature supports development of the EU safety directives related to radioactive solid material clearance. In particular, the IAEA has developed policy guidance found in a 1988 IAEA document, "Principles for the Exemption of Radiation Sources and Practices from Regulatory Control."

E.8 Summary of Chapter 8: Stakeholder Reactions and Involvement

This chapter reviews recent and current efforts by NRC to involve stakeholders in the decision-making process that are relevant for this effort on control of solid materials and presents basic principles that NRC can follow to involve its stakeholders more effectively.

E.8.1 Previous NRC efforts on related issues:

a) BRC Policy: The report discusses NRC's efforts in issuing the BRC policy.

   1) Scope of BRC: The BRC policy, issued in 1990, was intended to cover four basic areas, including termination of licenses for facilities, distribution of consumer products, disposal of materials with very low levels of radioactivity, and recycling or reuse of materials.

   2) Public process on BRC: There was issuance of a policy statement for public comment and a series of public meetings on the BRC policy.

   3) Problems indicated with BRC public process: The public meeting process became polarized and there was strong stakeholder opposition . Subsequently, there was an effort at a consensus building process which did not succeed as a result of stakeholders declining to participate because of certain conditions placed on participation and a general distrust of the BRC process by certain stakeholders.

   4) End point of BRC process: The BRC process was ultimately terminated in 1993 after the NRC rescinded the policy and Congress revoked it.

b) License termination rule (LTR): The report indicates the following in discussing NRC's efforts in issuing the LTR.

   1) Scope of LTR: The LTR provided criteria in the regulations for decommissioning of lands and structures at licensed facilities.

2) Public process on LTR: The LTR effort was begun with a series of public workshops in 1993 designed to identify issues, areas of concern, and disagreement. In addition, a "initial draft rule" was issued for review by stakeholders in early 1994. A proposed rule was published by the NRC in August 1994 after considering the outcome of the workshops, the results of a scoping process carried out under the National Environmental Policy Act (NEPA), and comments on the initial draft rule. The proposed rule contained a 0.15 mSv/yr (15 mrem/yr) standard for release of decommissioned sites and the use of site specific advisory boards (SSABs) for review of sites seeking restricted use.

3) Problems indicated with LTR public process: Subsequent to issuing the proposed rule after completion of the consensus process, a final rule was issued with a 0.25 mSv/yr (25 mrem/yr) standard and dropping of the SSABs for a performance based criteria for obtaining public advice on restricted use for a site. Environmental groups and the EPA had objected to the revision to the dose standard before issuance of the final rule because of health and safety concerns but no extensive stakeholder process was held to address these concerns.

   The report states that after publication of the proposed rule, the NRC should have been able to conclude a successful public participation process, however subsequent NRC actions fundamentally undercut the consensus that had been achieved, further alienating those who had participated.

4) End point of LTR process: The LTR process was completed in July 1997 with issuance of a final rule.

E.8.2 Current NRC efforts on control of solid material:

a) Public process for control of solid materials: In June 1999 the NRC published, for public comment, an Issues Paper indicating that NRC was initiating another "enhanced participatory process" for a proposed clearance rule. The process began with a series of four public meetings in fall 1999 and an additional stakeholder meeting with the Commission in May 2000.

   The report notes that the Issues Paper presented three alternatives including:

   1) Do not conduct rulemaking and continue the current case-by-case approach;
   2) Do not conduct rulemaking and explore options for updating existing guidance to improve consistency;
   3) Conduct a rulemaking.

   If the third option, rulemaking, were pursued, the Issues Paper noted that three "technical approaches" could be explored:

   1) Permit release for unrestricted use if doses are less than a specified level;

   2) Restrict release to only certain authorized uses; and

3) Prohibit release of material from areas where radioactive material is used or stored, otherwise allow clearance.

a) Problems with process used for effort on control of solid materials: The NRC's public meetings were initially boycotted by some national environmental and consumer advocacy groups as a result of their severe criticism of the NRC process, doubt as to whether it had been adequately reformed, and skepticism over whether it would be any different from the BRC or LTR processes.

b) Public views on alternatives: The NA report indicates that the Issues Paper does not capture the full spectrum of alternatives favored by stakeholder groups and presents information representing the range of stakeholder positions on preferred alternatives.

   1) Preclude any release of contaminated materials from regulatory control (no option specified but isolate solid waste from general commerce).
   2) Continue NRC's case by case process.
   3) Promulgate a restricted clearance standard (e.g., landfill disposal).
   4) Promulgate a clearance standard.
   5) A dialogue cannot be engaged in because the dialogue process is tainted.
   6) Delay decision until a process is established for arriving at a consensus and stakeholder views are integrated with NRC decision framework.

c) Themes of public concerns: Citizens groups did participate in the latter two fall 1999 public meetings and the May 2000 Commission meeting. In addition, NRC received over 800 comment letters on the Issues Paper. Three major themes in the stakeholders' comments are noted:

   1) There is little support for a clearance standard.

   2) There is a legacy of institutional distrust of the NRC by some of its stakeholder groups based on factors that undermine trust including: (a) the BRC and LTR experience noted in Section E.8.1, above; (b) NRC has not fully disclosed risks and uncertainties associated with a clearance standard; (c) NRC is just providing a "regulatory cover" for DOE to recycle its metal; (d) NRC is just focused on economic issues rather than protecting public health; (e) the NRC public process is merely implemented mechanically; and (f) NRC does not know how to implement a rule.

   3) Numerous stakeholders are unclear on the meaning or importance of certain technical terms and issues.

d) In summary, the report notes that the current situation is:

   1) Many stakeholders distrust the NRC and remain confused about important technical questions.

   2) There are misperceptions about intentions on both sides and NRC has not been effective in its risk communication.

3) There is no consensus evident among stakeholders about the alternatives.

4) The NRC must overcome serious levels of distrust generated by its actions during the BRC policy and the LTR efforts before the public participation process associated with the 1999 Issues Paper is likely to succeed.

<u>E.8.3 Risk communication and its role in the rulemaking process:</u> The report discusses the approaches for effective risk communication and notes the following:

a) <u>What effective risk communication is:</u> A report by the National Research Council indicates that risk communication is an interactive process of exchange of information and opinion among individuals and groups.

b) <u>Risk communication as part of Government business:</u> The concept of risk communication is consistent with federal laws on open government which were meant to promote public participation in NRC decision-making, including the Federal Advisory Committee Act, Sunshine Act, Freedom of Information Act, and the Administrative Procedures Act, and NEPA.

c) <u>NRC's successes and failures in risk communication:</u> NRC has successfully engaged in risk communication in limited contexts such as the initial public participation process during development of the LTR, however its inability to follow through on the 1994 consensus is an equally compelling example of poor risk management and communication.

d) <u>Difficulties of risk communication for control of solid materials:</u> Communicating risk and benefits of a clearance standard is challenging because:

    1) There are public concerns associated with radiation in general.

    2) Prior risk communication problems in the BRC and LTR cases have resulted in a stalemate on clearance issues, as well as increased distrust of the NRC.

    3) While NRC's request for stakeholder input on the issues paper should in principle be acceptable as an honest effort to respect and consider all stakeholder views, many stakeholder groups do not view it that way and have expressed concern that NRC did not solicit their views prior to publishing the Issues Paper.

    4) Many concerns are not related to technical issues but to issues of process.

    5) NRC is aware of "the state of the art" in using risk communication with both the public and decision makers through studies done in 1999; if NRC uses the studies, its efforts will be better informed than past work that employed, but did not follow through with, participatory processes and risk communication.

<u>E.8.4 DOE efforts:</u>

a) Recycling of nickel in Tennessee: DOE proceeded with efforts to recycle nickel and steel in Oak Ridge Tennessee. However, that effort was initiated with no public involvement or process, and subsequent review of this effort revealed several problems with the contractor involved in that work.

b) PEIS: DOE is presently developing a PEIS on recycling of metal from DOE facilities.

c) Links between NRC and DOE: Publicly perceived links between DOE efforts and NRC efforts have further undermined NRC's credibility. Stakeholders suggest that NRC and DOE are collaborating behind the scenes to establish standards allowing clearance.

E.8.5 The importance of trust.

a) Institutional trust is the single most important factor influencing acceptance of controversial government policies.

b) The NRC must be perceived as honestly presenting the level of risk associated with the policy.

c) When the NRC does not address issues consistently or has provided misinformation, stakeholder distrust develops.

d) The more transparent the process, the more likely it is that stakeholders will perceive that NRC has nothing to hide.

e) NRC has lost the trust and confidence of some of its stakeholders and must either work to regain trust or continue to contend with an adversarial relationship.

E.8.6 Examples of successes: Examples of successes in obtaining public trust are cited:

a) EPA: The EPA carried out an effort to publish for review a draft plan for public involvement in 2000.

b) U.S. Army: The U.S. Army carried out an effort to use a dialogue process designed by Keystone to obtain public acceptance of a method for destruction of chemical weapons.

c) U.S. Army Corps of Engineers: The Army Corps of Engineers carried out an effort to use partnering approaches to minimize disputes.

d) NRC use of these examples: NRC should reach out to the contractors that have been involved in the programs run by these other agencies.

E.8.7 Examples of how stakeholder involvement should work

a) Purpose of stakeholder involvement: The purpose is to give stakeholders an opportunity to be heard prior to a decision and to involve them in the framing of problems and solutions.

b) Dispute resolution techniques:

    1) Various types of such techniques may be appropriate at steps along the way including unassisted procedures, third party assistance including facilitation, mediation fact finding, nonbinding arbitration, and partnering.

    2) Approaches such as facilitation, fact finding, mediation, and nonbinding arbitration allow stakeholders to participate in the evaluation of alternatives, impacts, and proposed decisions; some forms of dispute resolution are designed to require stakeholder approval before a final decision is made.

c) Up-front determinations for stakeholder involvement process: Some determinations must be made before selecting and moving forward with any of the methods or techniques for public participation

    1) It is critically important that the agency and stakeholders both believe that they can benefit from the process whether it is a public consensus building process or an alternative dispute resolution approach.

    2) Entities must believe that the outcome is more likely to be favorable to them if they participate in the joint process rather than remain outside of the process.

    3) If the NRC is legally bound to one option, or if the agency does not believe that stakeholder involvement is important and worthwhile, these methods should not be employed; if parties on either side are not acting in good faith, such methods can do more harm than good.

d) Benefits from using public involvement strategies appropriately

    1) The NRC can build legitimacy for a decision.
    2) The NRC can gain new information and perspective.
    3) The affected public can gain new information and perspectives.
    4) All constituents are kept better informed.

E.8.8 NRC's next step: The report provides the following general suggestions on how NRC should proceed:

a) Some prior limited NRC success: The report notes that NRC has had limited success in obtaining meaningful stakeholder involvement.

b) Difficulty of rebuilding public trust: The report states that determining the proper strategy or process for NRC to increase effective public participation and rebuilding trust of stakeholder groups will be difficult .

c) Specific actions for NRC: If NRC truly believes that it is important and worthwhile to involve stakeholders, then:

    1) The NRC should assess willingness of stakeholder groups to begin a dialogue to

cover items contained in the Issues Paper, as well as all issues that stakeholders claim to have been omitted.

2) The NRC should address stakeholder views about desirable and feasible mechanisms for obtaining stakeholder input into: (a) how issues should be framed; and (b) how decision processes can be made transparent and open.

3) This assessment should be the first step toward rebuilding the credibility of the NRC and beginning to re-establish trust by stakeholders.

4) It is critical that the dialogue spells out up front what flexibility NRC has in responding to specific stakeholder concerns and where NRC feels it is statutorily precluded from taking action. This will allow stakeholders to know they can have some influence and to determine if this amount of influence on the outcome is sufficient to justify their participation in the process.

5) To increase belief that stakeholders that their input matters, NRC should provide ongoing feedback as to how the agency is using the input from the dialogue groups. This feedback should include when, and how, decisions were affected by input as well as the reasons why certain input did not have an affect.

6) Legitimacy can only be achieved by fostering trust in the NRC’s fairness, integrity, and competence; if the process appears biased, many stakeholders will view the process as biased.

d) Contractors: NRC has tended to rely on small and closed circle of contractors for certain services. Although this may simplify procurement of specialized technical services, it fosters negative perceptions by those outside the circle regarding the openness and fairness of the process and competence of the analyses.

E. 8. 9 Findings: Based on the analysis in the chapter, the report made the following findings in Chapter 8.

a) Finding 8.1 - Concerns of stakeholder with radiation and control of solid materials: The NRC involved stakeholders in the processes for the BRC policy and the LTR for decommissioning, as well as in the initial stages of considering standards for release of solid material. Despite these efforts, environmental and consumer advocacy groups remain concerned with radiation effects, and industrial groups continue to be concerned with the potential economic consequences of the clearance of solid material.

b) Finding 8.2 - Problems with past NRC stakeholder efforts: Most of the issues of concern to those stakeholder groups that oppose the NRC's recent efforts to establish a rule for the release of solid material are the same issues expressed by these groups 10 years ago during the effort to establish the BRC policy. The committee's review of the record on the BRC policy, the LTR, and the 1999 issues paper found that stakeholders distrust the NRC and remain confused about important technical questions. There are misperceptions about intentions on both sides, and the NRC has not been effective in its risk communication.

c) Finding 8.3 - Differing stakeholder views and principal concern with recycle: Stakeholder groups differed in their viewpoints on regulating disposition of solid material. Generally, professional societies associated with the nuclear industry supported clearance, industrial groups endorsed restricted use, and environmental groups opposed any type of clearance. However, much of the opposition to a clearance standard was associated with recycling metal into general commerce.

d) Finding 8.4 - Distrust of NRC among some stakeholders: A legacy of distrust of the NRC has developed among most of the environmental stakeholder groups. This distrust results from their experience with the BRC policy, the LTR, and the 1999 Issues Paper on the release of solid material. Reestablishing trust will require concerted and sustained effort the NRC, premised on a belief that stakeholder involvement will be important and worthwhile, as well as a prerequisite for making progress.

E.9 Summary of Chapter 9: Decision-Making Framework

This chapter provides information on a framework for decision-making about alternatives for control of solid material.

E.9.1 General:

a) Need to modify current approach: For the reasons noted in Section E.9.2, below, various stakeholders have argued for modifying or replacing the current approach. Stakeholder proposals for alternatives differ widely from no release, to unrestricted release, to restricted use.

b) Modifying current approach will be controversial: Given different and strongly held views, the development, evaluation, and implementation of a regulatory approach will likely create substantial controversy and will take significant time and effort to develop an acceptable solution.

c) Current approach is safe and adequate in the short term; but a process to revise is needed: The NA report recognizes there are problems with the current approach and that a new approach is needed, however the study committee has not found any evidence that the problems with the current approach cause significant health effects or amount to an immediate crises, and therefore concludes that it is possible for NRC to conduct, with deliberate speed, a thorough analysis and evaluation of several alternatives for control of solid material including a broad-based stakeholder involvement process.

d) Content of this section: This section discusses both a decision-making process (see Section E.9.3, below) and a systematic decision framework (see Section E.9.4).

E.9.2 Problems with current approach: The report notes problems with the current approach:

a) From a regulatory perspective: It has certain issues, including that: (1) it does not handle volume contamination generically, (2) it is not risk based, (3) it may lead to inconsistent determinations from one case to another; (4) the levels in Regulatory Guide 1.86 are dated, (5) the current levels have not kept up with international developments on release standards; and (6) the levels were not adopted through a rulemaking process.

b) From a NRC resource perspective: It can produce additional workload and cost for NRC (although this burden appears manageable for the foreseeable future).

c) From licensee's perspective: It is unpredictable and costly and creates undesirable operational impacts, and can cause future liabilities if materials released under Regulatory Guide 1.86 are later suspected to have caused harm.

d) From the perspective of environmental groups and some members of the public: It allows unrestricted use of solid material if it passes the surface contamination levels without external review; these groups do not favor dose-based standards as a remedy but rather a no-release approach.

E.9.3 Decision making process: The report discusses that NRC has various process options for making the decision about control of solid materials.

a) NRC regulatory authority: The report notes that, as the regulatory body, NRC holds the statutory decision-making authority.

b) Need for NRC to obtain public trust: Some concerned groups perceive the NRC as non-responsive to public input and some perceive the Commission and its staff as not operating cohesively. Unless confidence and trust in NRC increases, acceptance by the public and Congress of a clearance or restricted use standard is unlikely.

c) NEPA process: One way to proceed is to follow a variation of the NEPA process, including announcement of a proposal; solicitation of public input as to the appropriate range of alternatives and impacts through a scoping process; and subsequent review of environmental analysis with public input.

d) NEPA concept of tiering: This would allow NRC to obtain input on issues of broad scope and later move to NEPA review of increasingly specific options.

e) Lessons to learn from LTR process: The enhanced participatory rulemaking for the LTR was an open NEPA approach and appeared to have achieved consensus until the NRC's process changed following issuance of the proposed rule. NRC might reconsider the LTR experience to evaluate a tiered NEPA approach overall.

f) Involvement of affected groups: NRC decision-making processes can be improved by including a broad range of affected groups and individuals while remaining flexible, open transparent and fair. Administrative appeals processes and administrative guidelines may have to be altered to ensure greater access to NRC's decision making process by a broader range of affected parties.

g) AEA as basis for public involvement: The AEA provides a somewhat less extensive legal basis for public review or citizens suit challenges, however the AEA's legal basis is fully adequate if used properly and, whatever the AEA's shortcomings are, NRC can and must employ appropriate mechanisms to reach out to develop stakeholder participation, acceptance, and support.

h) Regulation of TENORM: A broad-based scoping process could include consideration of whether NRC should regulate TENORM by some national standard rather than continuing State-only regulation.

i) Public advisory committees: NRC might consider supplementing its decision process with enhanced and expanded use of public advisory committees. Many federal agencies include members of the broader public, not just highly technical experts, on their advisory committees.

j) Use of facilitators: Any process to develop a standard might be enhanced by using professional facilitators.

E.9.4 Alternative approaches: Alternative approaches for control of solid material listed in the report include:

a) Case-by-case approach: This involves NRC approving license conditions in accordance with Regulatory Guide 1.86 or modifications. The report notes that there is little support for minor modifications of the current approach, although it notes that it could be improved by developing additional criteria for volume contamination, possibly based on dose assessment using coefficients similar to those in development in NUREG-1640.

b) Dose-based clearance standard: Unrestricted reuse, including commercial recycling. The report notes that several possible dose limits for use in a dose-based standard have been discussed, including 1 µSv/yr (0.1 mrem/yr), 10 µSv/yr (1 mrem/yr), and 0.1 mSv/yr (10 mrem/yr).

c) Dose based restricted use standard: This alternative would involve beneficial reuse in controlled environments, e.g., shield blocks at DOE facilities. It is noted in the report that placing restrictions on use of the material has the effect of limiting potential exposure scenarios.

d) Dose based restricted use standard: This approach could involve, for example, landfill disposal and/or commercial reuses for low exposure scenarios, e.g., concrete rubble base for roads. As above, placing restrictions on use of the material limits potential exposure scenarios. It is noted that, because the critical group under this alternative might be less restrictive than for clearance, it would be possible to release solid materials with higher concentrations under a restricted use standard than a clearance standard.

e) No release: All solid material is disposed of at a LLW site.

E.9.4 Impacts and issues to consider in deciding on an alternative: The report discussed some impacts and issues to consider in deciding on an alternative. These include the following:

a) Health impacts and environmental impacts: The primary objective of any alternative for control of solid material is that there are minimal health and environmental impacts for any individual and the public at large. The report notes that:

1) Part of this analysis must be an evaluation of impacts from multiple sources and collective doses.

2) There is a need to consider indirect and unintended impacts of alternatives, including transportation impacts of shipping materials (including routine transportation accident risks), transport to landfills, etc.

b) Direct and indirect costs: It is important that NRC conduct a thorough cost analysis that accounts for:

1) The direct costs of disposal of solid material among the different alternatives, including whether the material goes to LLW site or to a landfill or into recycle. This should include a thorough cost analysis that accounts for differences in disposal options and the uncertainties in costs estimates caused by regulations and by supply and demand.

2) Transport costs and operational costs (material preparation and sample analyses). These other costs would be much lower than disposal costs.

3) Indirect costs of alternatives which include the potential liabilities of licensees and other waste handlers, as well as concerns from metals and concrete industries that they will suffer economic hardship because consumers would not want to buy their products because of concerns that they may contain radioactive material in them.

c) Direct benefits: The report noted that there will be some opportunity for direct benefit, for example sale of material as scrap.

d) Consistency with existing regulations: The report noted that consistency with other regulations and standards is desirable, though it is not the main reason for selecting an alternative. The following are noted:

1) There should be consistency with international, national, State, and local regulations.

2) There may be an economic advantage to the U.S. in establishing a clearance standard consistent with international standards which would make import-export and control of materials easier and, if monitored properly, of no consequence to public health.

3) Consistency with other Federal regulations is also important, in particular the approach to regulation preparation taken by EPA.

4) Also consistency with the regulation of other radioactive materials, in particular TENORM, is important.

e) Implementation, enforcement, and reporting: The report notes that to be effective and to establish confidence in any approach to control solid material, the approach must be implementable and enforceable, and that there must be a capability to detect, measure, and monitor very small amounts of radiation with few false alarms. There should also be reporting requirements.

f) Public perception: The NRC faces perhaps no greater challenge than winning widespread public acceptance of any regulation for control of solid material. It is noted that acceptance does not equate directly with consensus of unanimous agreement. The likelihood of public acceptance is increased by: (1) adhering faithfully to an announced process that engages all responsible stakeholder representatives and views; (2) being perceived as fair and open; (3) bringing out pros and cons of all alternatives in an even handed way; (4) participation throughout by informed and knowledgeable persons, and openness to a broad and creative range of alternatives.

g) Decision impact matrix: The report provides a suggested table (Figure 9-1) of how the impacts and issues discussed above should be considered in relation to the various alternatives under consideration.

E. 9. 5 Findings: Based on the analysis in the chapter, the report made the following findings in Chapter 9:

a) Finding 9.1 - Current approach does not have immediate problems; sufficient time to develop revised approach: The committee found no evidence that the problems with the current approach to clearance decisions require its immediate replacement. The committee concludes that there is sufficient time to conduct a thorough and systematic analysis and evaluation, including a sound process of stakeholder participation and involvement, of alternative approaches to the disposal of solid material.

b) Finding 9.2 - Alternatives: Although there are many possible alternatives for the disposal of solid material from NRC-licensed facilities, the committee heard substantial support from stakeholders for only a few. In general terms, the supported alternatives are a dose-based clearance standard, a dose-based restricted use standard and a no-release policy. Different stakeholders expressed preferences for different conditions for a dose-based restricted use standard: beneficial reuse in controlled environments, commercial reuse in low-exposure scenarios, or landfill disposal. Source-based standards and minor modifications of the existing case-by-case approach received limited support.

c) Finding 9.3 - Analysis of impacts and benefits: There are many possible impacts of the approaches that the NRC might select for the clearance of solid material. Potentially important impacts include the degree of public protection against exposure from radioactive materials, environmental impacts, direct costs (e.g., for disposal), indirect costs (e.g., through product stigmatization), consistency with existing regulations, implementation and enforcement, and public perception. To date, the NRC has focused its analyses of alternative approaches fairly narrowly on protecting the public from exposure to solid material. The NRC has done very little analysis of the other important impacts on this list.